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Unusual Mechanisms of Injury of Distal Radius and Ulna in India -A Multicenter Case Series Highlighting Emerging Socio-Behavioral Trauma Patterns

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Abstract

Background: Distal both-bone forearm fractures are common injuries with well-described mechanisms. However, evolving sociobehavioral practices may generate novel injury patterns.

Methods: We report a case series of four adult patients presenting with distal radius and ulna fractures following two-wheeler accidents. All patients were wearing helmets over their forearms at the time of injury. Clinical records, radiographs, mechanism of injury, treatment, and outcomes were analyzed.

Results: All patients sustained fractures of both distal radius and ulna following wrist entrapment within the helmet aperture during a fall. Fracture patterns were unstable, with frequent comminution and intra-articular extension. Surgical fixation was required in three patients. All fractures united with satisfactory functional outcomes.

Conclusion: Wrist entrapment within a helmet represents a novel and preventable mechanism of distal both-bone forearm fractures unique to improper helmet usage. Awareness of this injury pattern is essential for early recognition, appropriate management, and prevention.

Keywords: Distal radius fracture; Distal ulna fracture; Helmet entrapment injury; Two-wheeler accidents; Unusual injury mechanism; Forearm fractures

Introduction

Fractures of the distal radius and ulna constitute one of the most common skeletal injuries encountered in orthopedic practice and represent a significant burden on healthcare systems worldwide. They account for nearly one-sixth of all fractures treated in emergency departments. The functional importance of the wrist joint, combined with its complex anatomy and load-bearing role in daily activities, makes these fractures clinically significant, with potential long-term consequences on hand function and quality of life. Traditionally, distal forearm fractures have been classified based on patient age, bone quality, fracture morphology, and mechanism of injury.

Pediatric fractures are usually incomplete and stable due to elastic bone properties, whereas adult fractures tend to be unstable and intra-articular, particularly in high-energy trauma. Elderly patients, especially postmenopausal women, frequently sustain distal radius fractures following low energy falls due to osteoporosis. Although classical mechanisms such as fall on the outstretched hand (FOOSH), road traffic accidents, and sports-related trauma are well documented, evolving social behaviors and traffic patterns have led to the emergence of newer injury mechanisms. In developing countries such as India, unique socio-legal practices influence trauma patterns. The present study documents a novel;

preventable mechanism of distal both-bone forearm fractures related to improper helmet usage during two-wheeler travel.

Materials and Methods

This retrospective case series was conducted at a tertiary care trauma center between January 2025 and June 2025. Adult patients presenting with distal both-bone forearm fractures following two-wheeler accidents were screened. Inclusion criteria were: [1] age >18 years, [2] fractures of both distal radius and ulna, and [3] history of helmet worn on the forearm at the time of injury. Demographic data, injury mechanism, fracture classification, treatment modality, and outcomes were recorded. Radiological union was defined as bridging callus across three cortices. Functional outcome was assessed by wrist range of motion and return to daily activities.

Epidemiology

Distal forearm fractures demonstrate a bimodal age distribution, with peaks in childhood and older adulthood. In children, the high incidence is attributed to increased outdoor activities and incomplete neuromuscular coordination. In contrast, the elderly population sustains these fractures due to impaired balance, reduced protective reflexes, and decreased bone mineral density. In India, the epidemiology differs from Western countries due to heavy dependence on two-wheelers for daily transportation. Road traffic accidents constitute a major contributor to musculoskeletal trauma.

Two-wheeler riders account for a disproportionate number of upper-limb injuries, with the wrist and forearm being particularly vulnerable as riders instinctively extend their hands during falls. The increasing enforcement of helmet laws has changed rider behavior. Instead of continuous helmet use, many riders adopt temporary compliance strategies, such as carrying helmets on the forearm. This behavioral adaptation has inadvertently introduced a new risk factor for distal forearm injuries.

Etiology and Biomechanics

FOOSH injuries transmit axial compressive forces to the distal radius. In contrast, helmet entrapment creates a distinct biomechanical environment. During a fall: [1] the palm contacts the ground, [2] the helmet rim fixes the wrist, [3] the forearm continues to rotate, and [4] a torsional moment concentrates at the distal metaphysis. This lever-arm effect converts translational energy into rotational and bending stresses, causing simultaneous failure of both radius and ulna and explaining the complex fracture patterns observed.

Unique Mechanism Observed in India

We observed four adult patients presenting to our emergency department with distal both-bone forearm fractures following road traffic accidents, where all patients were riding two-wheelers while wearing helmets over their distal forearm or wrist instead of on the head. In India, two-wheeler commuting is extremely common. Due to historically inconsistent enforcement of helmet laws, riders and pillions often avoided wearing helmets. With recent stricter penalties, a widespread practice has emerged in which riders temporarily wear helmets on the forearm and shift them to the head only when approaching traffic police (Figure 1).

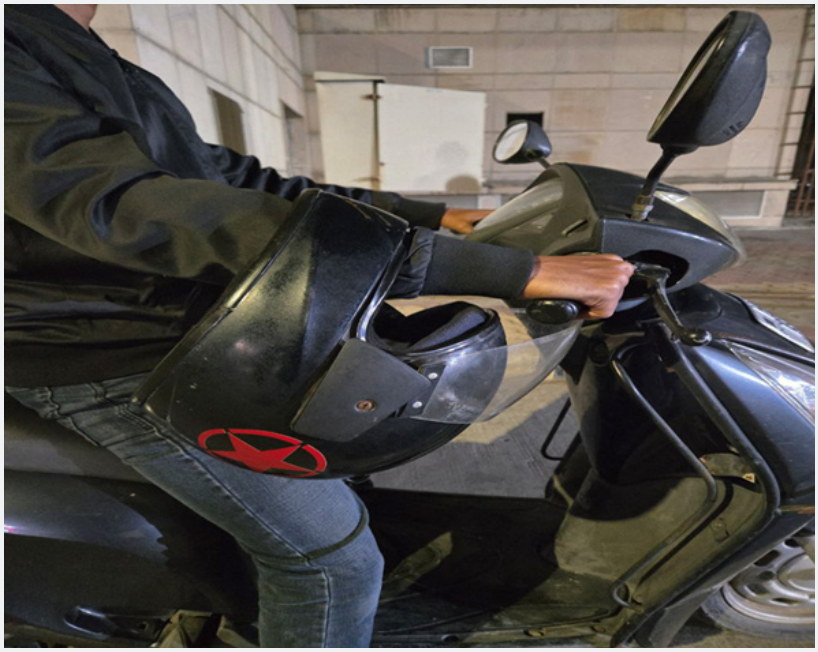

Figure 1: Improper helmet carriage over the forearm during two-wheeler riding, demonstrating potential wrist entrapment within the helmet visor opening.

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In all four cases, during a fall from the two-wheeler, the wrist became entrapped within the chin guard and visor opening of the helmet. The helmet acted as a rigid circular lever arm, transmitting torsional and bending forces to the distal forearm, resulting in simultaneous fractures of the distal radius and ulna with extensive soft tissue injury. A representative demonstration of this improper helmet carriage over the forearm is shown in Figure 1. In this position, the wrist is frequently positioned within the visor opening or chin guard of the helmet.

Case Series (Clinical Presentation and Management)

Four adult patients presented with distal both-bone forearm fractures following two-wheeler accidents. A consistent history of helmet carriage over the forearm was obtained in all cases.

Case I: A 28-year-old male fell from a motorcycle at moderate speed while wearing a helmet over his right wrist. Radiographs showed a displaced extra-articular distal radius fracture (AO 23-A2) with distal ulna metaphyseal fracture. He underwent volar locking plate fixation of the radius and K-wire fixation of the ulna. At 6 months, radiological union and full functional recovery were achieved.

Case II: A 34-year-old female pillion rider fell after a skid while carrying the helmet over her left forearm. Radiographs revealed a comminuted intra-articular distal radius fracture (AO 23-C1) with distal ulna fracture. She underwent open reduction and internal fixation with a volar plate. Union occurred with near-normal wrist motion.

Case III: A 41-year-old male sustained an open distal forearm injury after a collision with a car while wearing the helmet on his forearm. Radiographs showed an open comminuted intra-articular distal radius fracture (AO 23-C2) with distal ulna fracture. Emergency debridement and staged fixation were performed. Union occurred by 5 months with acceptable wrist function.

Case IV: A 36-year-old male fell forward while holding a helmet over his right wrist. Radiographs showed a distal radius fracture (AO 23-A3) with ulna styloid fracture. He was treated conservatively. Union was achieved at 3 months with mild residual stiffness [5,6] (Table 1).

Table 1: Summary of Cases.

Case	Age	Sex	Side	AO Radius Type	Ulna Injury	Treatment	Outcome
1	28	M	Right	23-A2	Distal metaphyseal	ORIF + K-wire	Excellent
2	34	F	Left	23-C1	Distal metaphyseal	ORIF	Good
3	41	M	Right	23-C2 (Open)	Distal metaphyseal	Staged fixation	Good
4	36	M	Right	23-A3	Ulnar styloid	Cast	Fair

Discussion

Distal both-bone forearm fractures are commonly encountered in orthopedic practice; however, the mechanism described in this case series represents a novel injury pattern that has not been adequately documented in existing literature. While the role of helmets in preventing head injury is well established, their implication in upper-limb trauma due to improper usage remains largely unrecognized. In all four cases, a consistent history was obtained: the helmet was worn over the forearm at the time of the accident. This reflects a growing trend in India, where riders attempt partial compliance with helmet laws. This socio behavioral adaptation has unintentionally introduced a new risk factor for distal forearm fractures.

The helmet converts translational energy into rotational stress, producing a powerful lever-arm effect at the distal metaphysis. This explains the consistent involvement of both bones, increased comminution, and frequent intra-articular extension. These fractures may be deceptively underestimated at presentation. Surgeons should maintain a low threshold for advanced imaging, careful distal radioulnar joint assessment, and early surgical stabilization. This injury pattern is entirely preventable and represents an unintended consequence of partial compliance with safety regulations. Public education must emphasize continuous helmet use rather than temporary compliance.

Clinical and Public Health Implications

Surgeons must inquire about helmet positioning. These fractures may be more unstable than FOOSH injuries. Public education must discourage carrying helmets on the forearm.

Limitations

This study is limited by its small sample size and retrospective design. Larger multicenter studies and biomechanical simulations are required.

Conclusion

Helmet entrapment–associated distal both-bone forearm fractures represent an emerging, uniquely Indian injury mechanism driven by sociobehavioral adaptation to traffic regulations. Recognition of this pattern is essential for diagnosis, management, and prevention.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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